IMPROVING THE EFFECTIVENESS OF INCENTIVE CONTRACTING

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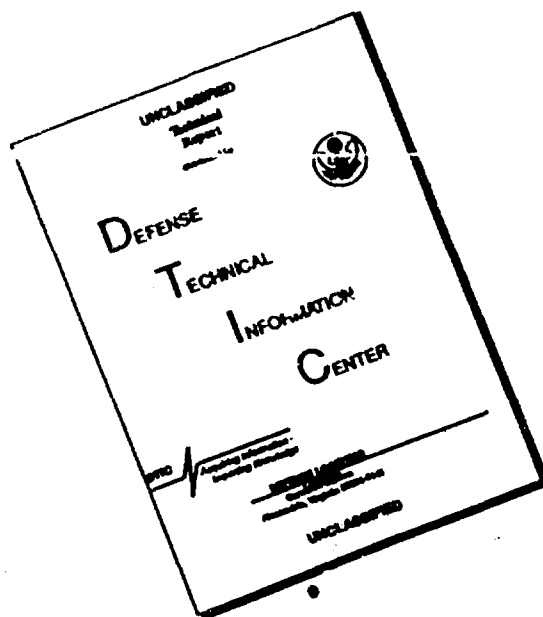
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I. INTRODUCTION

Present defense procurement policy relies heavily on the use of
incentive contracts to provide contractors with some inducement to
control costs. The intent is to encourage contractors through in-
creased profits toward more efficient performance and improved cost
control. This paper identifies the various effects that incentive
contracts may have on contract costs, and questions the validity of
the cost savings commonly attributed to these contracts. Several pos-
sible strategies for improving their effectiveness are also discussed.

In 1962 the Armed Services Procurement Regulations (ASPR) were
revised to encourage increased use of incentive contracts. These
changes reflected a consensus within the Defense Department that the
cost-plus-fixed-fee (CPFF) contracts then commonly used to purchase
major weapon systems did not provide adequate incentive for contrac-
tors to control costs. The revisions establish cost-plus-incentive-
fee (CPIF) contracts as preferable for research and development effort,
and recommend the use of firm-fixed-price (FFP) or fixed-price-incen-
tive (FPI) contracts for production.[**] Use of CPFF contracts is limited

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[**]
All fixed-price contracts provide incentives for tighter cost
control and more efficient production. Firm-fixed-price (FFP) con-
tracts provide the maximum incentive, since the price remains fixed
once contract negotiation has been completed. These contracts have
been traditionally regarded as incentive contracts *par excellence*.

to situations involving considerable uncertainty where incentive-type
contracts would be impractical.

The result of these changes has been a substantial increase in
the use of FFP and other incentive-type contracts for defense pro-
curement. As Table 1 illustrates, the shift away from CPFF contracts
toward incentive-type pricing arrangements has been striking. While
CPFF contracts accounted for more than one-third of total defense
expenditures in 1960, only about 10 percent of the 1967 total was
under CPFF contracts. This decline illustrates the impact of these
revisions on defense contracting practices.

CPFF pricing arrangements provide little, if any, inducement
for contractors to control costs or improve performance; in fact,
CPFF contracts may motivate contractors to increase costs.[*] Incentive
contracts, on the other hand, supposedly induce contractors to reduce
costs. By increasing the total profit as actual costs are reduced
below a target, incentive contracts encourage contractors to achieve
cost underruns. These contracts also place greater financial risk on
the contractor, since the Government no longer completely absorbs
cost overruns.

It is true that cost overruns have been smaller and less frequent
under incentive contracts than under CPFF contracts. This is inter-
preted by Defense Department officials as evidence that a contractor's
performance is more efficient under an incentive contract. In fact,
in evaluating the impact of incentive contracts on procurement costs,
former Secretary of Defense McNamara stated that costs under incen-
tive contracts would be 10 percent lower than they would be under CPFF
pricing arrangements.[**] Nonetheless, there are some valid reasons for
questioning the extent of the cost savings claimed for these contracts.
The most important reason is that cost underruns often may be achieved
without any real cost savings to the Government.

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[*] See H. M. Carlisle, "Incentive Contracts: Management Strategy
of the Department of Defense," *Public Administration Review*, Vol. 24,
March 1964, pp. 21-28.

[**] *Statement of Secretary of Defense Robert S. McNamara Before the
House Armed Services Committee on the Fiscal Years 1966-1970 Defense
Program and the 1966 Defense Budget*, February 18, 1965, Senate Sub-
committee on DOD Appropriations, p. 187.

Table 1

PROPORTION OF TOTAL DEFENSE EXPENDITURES
BY TYPE OF PRICING ARRANGEMENT
(% of Total Defense Expenditures)

Contract Type	Fiscal Year							
	1960	1961	1962	1963	1964	1965	1966	1967
Fixed-price								
FFP	31.4	31.5	38.0	41.5	46.3	52.8	57.5	56.3
FPI	13.6	11.2	12.0	15.8	18.5	16.6	15.9	17.8
Other	12.4	15.2	10.8	7.6	6.4	7.1	5.8	4.8
Cost-reimbursable								
CPFF	36.8	36.6	32.6	20.7	12.0	9.4	9.9	10.4
CPIF	3.2	3.2	4.1	11.7	14.1	11.2	8.3	8.3
Other	2.6	2.3	2.6	2.7	2.9	2.6	2.4	2.4

SOURCE: Directorate for Statistical Services, OSD, *Military Prime Contract Awards*.

II. MECHANICS OF INCENTIVE CONTRACTS

To understand how cost underruns may be effected without benefit of real cost savings to the Government, consider the factors that determine the contractor's profit under an incentive contract. Total profit received by the contractor consists of two components,

$$P = p_t C_t + \alpha(C_t - C_a)$$

where P = total contract profits;

p_t = rate of profit allowed on the target cost;

C_t = target cost;

C_a = actual cost;

and α = incentive sharing rate.

The first component, $p_t C_t$, is the profit amount on the initial target cost. The second component is a profit-sharing arrangement by which contractors retain part of any cost underrun that may result but must bear a portion of any cost overrun. The term inside the

parentheses is the difference between the target and actual cost; it is an overrun when actual cost exceeds the target, and an underrun when actual cost is less than the target.[*]

The incentive feature operates through this profit-sharing arrangement. To obtain increased profits, the contractor must achieve a cost underrun. For each dollar increase in underrun, the contractor retains α percent as increased profit, providing motivation for the contractor to achieve as large an underrun as possible.

Underruns and increased profits would result were the contractor to perform more efficiently and hold actual costs below the target value. This is the effect desired by Defense Department officials. Overruns and underruns, however, also depend on the value of the target cost, and an obvious strategy for avoiding cost overruns and increasing underruns would be for the contractor to increase the target cost to whatever extent possible. Whether this can be done, of course, depends on the circumstances under which the target is determined. Consequently, whether observed cost underruns reflect real cost savings and increased efficiency depends on the validity of the target cost.

So long as target costs are determined competitively, there need be little concern over their precise values. The market forces that operate in a competitive environment will eliminate the possibility of obtaining excessive targets. The difficulty lies in determining appropriate target values for contracts negotiated without a background

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[*]Changes and modifications in contract specifications that occur after the target has been established also provide an opportunity for the contractor to increase the target cost above the expected value. More precisely, the profit formula should be written

$$P = p_t' C_t' + \alpha(C_t' - C_a)$$

where p_t' is the rate of profit allowed on the target cost plus the cost of supplemental changes and modifications, and C_t' is the initial target cost plus the costs of the changes.

Since the cost of supplemental changes and modifications is negotiated, the contractor may be motivated to suggest numerous changes in the original specifications because it provides an opportunity to increase the target cost and may improve the likelihood of achieving an underrun. It also increases the total profit by the amount of the additional profit allowed on the changes.

of market price information. When target costs must be negotiated
under these circumstances, contractors may be able to increase their
expected profits and reduce the likelihood of cost overruns by bargain-
ing for larger targets--targets that exceed their actual expected costs.

This point is illustrated in Fig. 1, which shows a hypothetical
distribution of cost overruns and underruns.[*] In (a), the target cost
is determined competitively and is equal to the contractor's antici-
pated actual cost. In this case the expected overrun/underrun, labeled

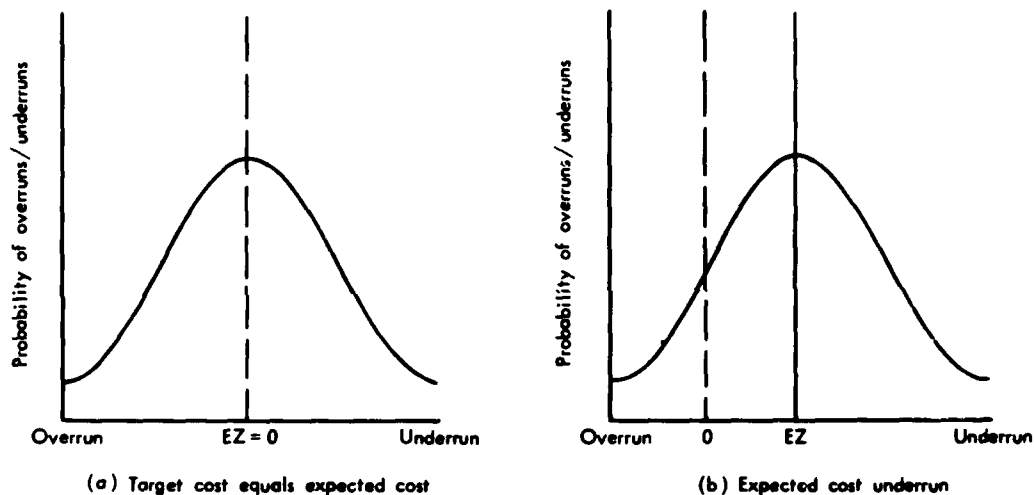(a) Target cost equals expected cost   (b) Expected cost underrun

Fig. 1 -- Distribution of cost overruns/underruns

EZ, is equal to zero, so that overruns and underruns are likely to
occur with equal probability. Persistent underruns could then properly
be attributed to improved performance and reduced costs. If the

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[*]Actual cost may differ substantially from its expected value
because of numerous elements of uncertainty. For this reason it is
appropriate to describe the actual cost outcome in probabilistic
terms. Obviously, the resulting underrun/overrun is also a random
variable with the same probability distribution as the actual cost.

target cost must be negotiated, however, and the Government is unable
to estimate the contractor's expected cost accurately, the contractor
may be able to negotiate a target that exceeds the expected cost so
that, on average, an underrun results. This is shown in (b).

In short, incentive contracts really provide two different incen-
tives: overstated target cost estimates, and reduced actual costs.[*]
For this reason it is not clear whether the underruns observed with
incentive contracts result from real cost reductions or from larger
target costs[**] and, as a result, it may be misleading to attribute
these underruns to increased efficiency.

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[*]The relative importance of these two incentive effects depends
on the values of the incentive sharing rate and the rate of profit
allowed on the contract. For example, differentiating the profit
function with respect to both target cost and actual cost yields:

$$dP/dC_t = (p_t + \alpha)$$

and

$$dP/dC_a = -\alpha \quad .$$

The first term is the marginal effect on profits from a change
in the target cost; the second is the marginal effect of a change in
the actual cost. Since $dP/dC_t > 0$, an increase in the target cost
results in an increase in the total profit. On the other hand, since
$dP/dC_a < 0$, an increase in actual cost reduces the total profit.
Since $(p_t + \alpha) \geq \alpha$, the effect of increasing the target cost by one
dollar outweighs the effect of reducing actual costs by the same
amount, and as long as $p_t > 0$, the incentive to overstate target costs
will be more tempting than will be the incentive to reduce actual costs.

[**]Available evidence indicates that the underruns observed with
incentive contracts are generally unrelated to the profit-incentive
features of these contracts. This is not consistent with the hypothe-
sis that stronger incentives lead to improved efficiency and lower
costs, but indicates, instead, that observed underruns probably result
from larger target costs. See I. N. Fisher, *Cost Incentives and Con-
tract Outcomes· An Empirical Analysis*, The RAND Corporation, RM-5120-PR,
September 1966. Other evidence also suggests that target costs may be
larger for contracts with profit-incentive features. John Cross, in
his *A Reappraisal of Cost Incentives in Defense Contracting*, Institute
for Defense Analysis, P-282, 1966, explains it as the compensation
required to induce contractors to bear greater risk. It is further
discussed in the Appendix of this Paper.

III. INCREASING THE EFFECTIVENESS OF INCENTIVE CONTRACTS

This discussion reveals the importance of the target cost in obtaining real and meaningful incentives. If the target is too high there can be little incentive for the contractor to reduce costs. The resulting underruns in this case will be unrelated to any real cost savings or increased efficiency. On the other hand, if the target is too low the contractor stands little chance of meeting it and, as a result, product quality and performance may also suffer. It is apparent that the key to effective incentive contracts is to obtain realistic targets that provide effective motivation for cost reduction.

Provided target costs are determined competitively, there is little chance of obtaining targets that significantly exceed contractors' anticipated costs. In the present procurement environment, however, target costs for most of the incentive contracts awarded for major weapon systems are negotiated without benefit of competition (incentive contracts, in fact, often seem to be regarded as a substitute for competition). This is because the DOD typically awards production and follow-on contracts to the original development contractor without competition from alternative suppliers. As a result, effective price rivalry can exist only at the first stage of the program--the development stage. Once the contractor obtains the initial development contract, he is virtually assured of receiving subsequent production and follow-on contracts without fear of competition from other potential producers. Because the targets for these contracts must be negotiated without market price information, it is extremely difficult for the Government to determine whether the resulting target cost is reasonably close to the contractor's expected cost. Contractors may thus be able to obtain targets sufficiently above their anticipated costs so that the likelihood of achieving a cost underrun and greater profits is increased substantially.[*]

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[*]Procurement officials recognize the difficulty accompanying this method of awarding contracts for major weapon systems. For example, in an address before the Institute on Management of Pre-Development Phase of Government Contracts (September 1965) Deputy Assistant Secretary

To determine realistic prices for major weapon systems and also
to provide targets that result in real efficiency incentives, an
obvious and familiar suggestion is that of using competition more
extensively in weapon system procurement. In recent years, a number
of alternatives have been proposed and several appear quite promising.
These techniques range from total package procurement where one con-
tract is awarded competitively for the entire program, to complete
separation where each development, production, and follow-on contract
is awarded competitively to the same or to various contractors.[*] While
one of these alternatives may be more suitable than another for a
particular procurement situation, all offer important advantages over
present weapon system procurement practices.

The importance of utilizing competition to determine target costs
in weapon system procurements cannot be overemphasized. Nonetheless,
there will be many situations in which price rivalry cannot be effec-
tively used--situations where technical uncertainties are large, the
number of potential suppliers limited, etc. It seems likely, moreover,
that a large portion of all weapon system procurements will continue
to be made without benefit of competition. In such cases the DOD must
rely upon its cost estimating capability to provide reasonable target
costs. Thus, another important method for increasing the effective-
ness of incentive contracts is through improved cost analysis and
estimating techniques.

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of Defense (Procurement) John M. Molloy stated:

> While most production and support contracts are either
> fixed-price or contain incentives, these arrangements are nego-
> tiated for the most part in a noncompetitive environment and may
> or may not have resulted in the establishment of targets which
> provide a contractor real and meaningful incentives. These cir-
> cumstances provide the strongest incentive to increase the com-
> petitive aspects of systems procurement.

Nonetheless, none of the more favorable techniques available has been
utilized extensively.

[*]Possible techniques include total package procurement, parallel
research and development, second sourcing, and separation. G. R. Hall
and R. E. Johnson discuss the merits and limitations of these alter-
natives in *Competition in the Procurement of Military Hard Goods*, The
RAND Corporation, P-3796, March 1968.

Recognizing the importance of improved cost information, the DOD
has given considerable attention to improving its cost estimating
capability. Much effort has been devoted to developing a comprehensive
data base consisting of cost information from previous weapon system
acquisitions. The DOD has also improved its cost estimating method-
ology and its cost reporting systems,[*] and some procurement officials
now believe that cost estimating techniques can be refined to the
point where they become an effective substitute for price competition
in establishing realistic target costs.[**]

Although cost estimation plays an important role in obtaining
improved cost information, it cannot provide cost estimates that are
in any sense equivalent to the costs that would result through compe-
tition among potential suppliers. There are two reasons for this.
First, cost estimation relies extensively on past experience to pro-
vide estimates of the costs of proposed weapon systems; consequently,
the estimates obtained in this manner can be no better than the under-
lying data upon which they are based. If the costs for the previous
weapon system procurements were not obtained competitively, the re-
sulting estimates obviously cannot be regarded as being comparable to
competitively determined costs. Unfortunately, the majority of weapon
system contracts contained in the DOD's data bank were not awarded
competitively. More important, many of these contracts were CPFF,

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[*] The Truth-in-Negotiations Act (PL 87-653) is intended to insure
the reliability and accuracy of contractor-furnished cost information.

[**] The rationale for this is made clear in the following remarks
presented by Harold Asher, former Deputy for Cost Analysis to the
Assistant Secretary of Defense (Systems Analysis), in an address to
the Operations Research Society of America, October 16, 1966:

> ... the assumption is made that DOD is able to estimate the
> cost of a new weapon system at least as accurately as any single
> contractor. The reasonableness of this assumption should be
> apparent. DOD's cost experience is based on all the weapons
> produced for DOD, while a single company has only its own past
> programs as an experience base. The assumption is predicated
> on the effort we are now making to exploit this greater amount
> of data and experience.

so that costs were possibly several times larger than they might have been otherwise.

Second, even if all contracts included in the data bank had been awarded competitively, the resulting cost estimates would not be equivalent to competitively determined costs. The reason is that cost estimation utilizes data from a number of contracts with different contractors to derive an estimate of the cost of a proposed weapon system. Because some contractors are more efficient than others, this estimated cost is in reality an average cost--an estimate of the cost that would result for a firm of average efficiency. As a result, competitively determined costs would generally be lower than estimated costs and the difference could be substantial. Nonetheless, estimated target costs can still provide some positive efficiency incentives for the less efficient contractors and, as a result, are useful in situations where competition is impractical.

In short, although competition is the preferred means for obtaining cost targets, cost estimation provides a useful tool in situations where competition cannot be utilized effectively. The important point is that these estimated costs may be considerably larger than competitively determined costs and might not provide the strongest efficiency incentives. Since competition is unlikely to be feasible in the majority of weapon system procurements, however, any improvements that can be made in cost-estimating methodology are probably well worthwhile.

IV. CONCLUSIONS

It is commonly believed that incentive contracts provide substantial entrepreneurial motivation for increased efficiency and tighter cost control. This belief is one of the stronger justifications for the current extensive use of incentive contracts. Yet, given present procurement practices, it is unlikely that incentive contracts have had any real effect on costs or efficiency. Because many incentive contracts continue to be awarded without meaningful price competition, there can be no guarantee that the negotiated targets are sufficiently

close to contractors' expected costs to provide any incentive for
increased efficiency. What is needed to make these contracts more
effective are realistic targets. Thus, future gains in incentive
contracting are likely to come through better ways of obtaining cost
targets--increased competition and improved methods of cost estimation.

Appendix

RATIONALE FOR HIGHER TARGET COSTS
WITH INCENTIVE CONTRACTS

Assuming contractors are generally risk-averse, some compensation is required to offset the increased risk created by incentive contracts. This compensation can be provided in several ways. An obvious method would be for the Government to increase target profits on these contracts. In practice, however, it may not be possible to raise profits sufficiently to offset the increased risk because very large profit rates are politically unacceptable. On the other hand, contractors may be able to reduce the level of risk by negotiating larger target costs--targets that exceed anticipated actual costs. This strategy reduces risk by lowering the likelihood of incurring a cost overrun, and is justified whenever expected profits are not adequate for the given risk level. Unfortunately, the underruns that accompany these larger targets may be erroneously attributed to increased efficiency and reduced costs.

The profit rate, sharing rate, and expected overrun/underrun are related through their effect on the contractor's utility level. For example, increasing the profit rate would increase both the contractor's profit and his utility so long as the sharing rate and expected overrun/underrun remained constant. Similarly, increasing the expected underrun (by increasing the target cost) for a given profit rate and sharing rate also increases the contractor's profit and utility. An increase in the sharing rate, on the other hand, increases the financial risk and may decrease the contractor's utility level, especially if an overrun is likely. In this case it would be necessary to raise the profit rate or reduce the expected overrun in order to prevent the contractor's utility level from declining.

Figure 2 shows a hypothetical utility surface for a risk-averse contractor, and illustrates the required tradeoffs between the sharing rate, profit rate, and expected overrun/underrun necessary to maintain a given level of utility. Given a contract with expected overrun/underrun equal to zero, for example, the tradeoff between the profit rate and the sharing rate necessary to hold the level of utility
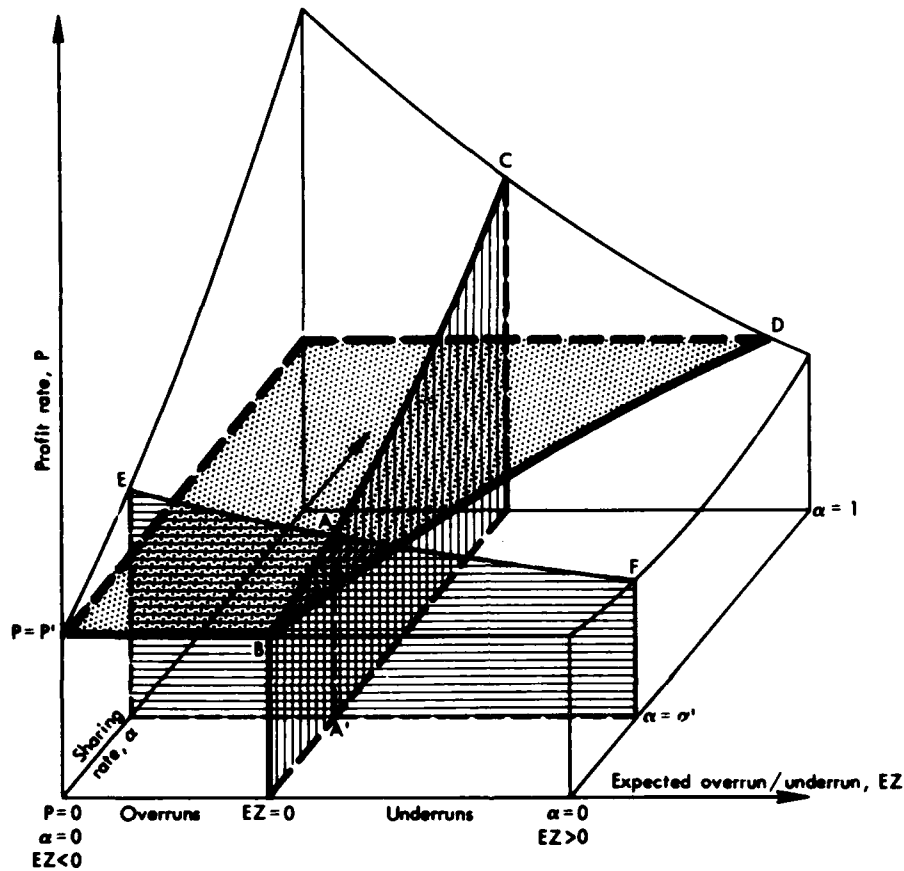
Fig. 2 -- Iso-utility surface

constant is indicated by line segment BAC. As the sharing rate in-
creases, larger profit rates are required to offset the increased risk
resulting from the larger sharing rate values.

The effect of increased risk on both the required profit rate and
the target cost can be determined easily from Fig. 2. Consider a
minimum-risk CPFF contract with profit rate P' and zero expected over-
run/underrun. This contract corresponds to point B on the contractor's
utility surface. Now suppose that the Government replaces this con-
tract with an incentive agreement having a sharing rate value equal
to α'. In order that the contractor be indifferent between these two

contracts, the profit rate must be increased from P' to that level
corresponding to point A on the utility surface. The greater profit
rate compensates the contractor for the increased risk introduced by
the larger sharing rate value; the increased profit resulting from
the greater profit rate is the risk premium necessary to maintain a
constant level of contractor satisfaction.[*] As the sharing rate value
is further increased, the required profit rate also increases until,
at point C (FFP contract with sharing rate value equal to unity), the
required rate of return is maximum.

Now suppose that P' is the maximum rate of profit that is polit-
ically acceptable to the Government. From Fig. 2, it is clear that
this rate of profit does not permit compensation for the riskier in-
centive contracts with larger sharing rate values. If contractors
are forced to accept incentive pricing agreements at this rate of
profit, however, their utility level will decline substantially. In
order to prevent this, contractors may attempt to reduce risk by lower-
ing the probability of incurring an overrun. This can be done by
negotiating larger target costs--targets that are sufficiently greater
than anticipated actual costs so as to virtually assure a cost under-
run--and by controlling actual costs more closely. In this example,
line segment BD indicates the increase in expected underrun necessary
to offset increases in the sharing rate and maintain a constant level
of utility.[**]

In the illustration, underruns become more likely as the pricing
arrangement is shifted from cost-reimbursable to incentive and as the

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[*]Risk increases even though the expected overrun/underrun is zero,
because the overrun/underrun is a random variable and there is some
probability of very large overruns, as well as underruns, occurring.
Consequently, the likelihood of cost overruns becomes more serious to
the contractor as the sharing rate value becomes larger.

[**]Contractors may also use this strategy to increase their utility
level beyond that level corresponding to the CPFF pricing arrangement.
Thus in some cases, contractors may be much better off with incentive
contracts. This, of course, depends on the conditions under which the
target cost is established and on the uncertainty surrounding the
anticipated actual cost.

sharing rate value becomes larger. This occurs because the contractor
is motivated to reduce risk; i.e., by increasing the target cost and
by reducing actual costs, the level of risk can be substantially
lowered. Unfortunately, there is a tendency among procurement offi-
cials and defense contractors to attribute underruns observed with
these contracts to lower actual costs, when it is in fact equally
likely that they result from larger target costs.